JoSSED 2(2) (2021)

Journal of Science and Science Education

http://jppipa.unram.ac.id/index.php/jossed/index

Physicochemical Properties of Used Cooking Oil Purified Using Shallot *(Allium Cepa L.) Peel Adsorbent*

Baiq Fitri Rahmayanti[1,2*], Yudin Citriadin[1], Sulistiyana[1], Azlan Kamari[3], Ali Al-Mokaram[4]

[1] Chemistry Study Program, Mataram State Islamic University, Lombok, West Nusa Tenggara, Indonesia.
[2] Master Of Science Education Study Program, University Of Mataram, Lombok, West Nusa Tenggara, Indonesia.
[3] Nanotechnology Research Centre, Faculty of Science & Mathematics, Universiti Pendidikan Sultan Idris, Malaysia
[4] Department of Chemistry, College of Science, Mustansiriyah University, Baghdad, Iraq

DOI: 10.29303/jossed.v2i2.920

Article Info
Received: August 26th, 2021
Revised: September 28th, 2021
Accepted: October 31th, 2021

Abstract: Damage to used cooking oil is caused by hydrolysis and oxidation processes, these reactions are formed due to the use of oil many times. In terms of physical damage occurred in the smell and color (brown oil, cloudy to blackish), chemical changes in the form of acid numbers and peroxide numbers are quite high. This study aims to determine (1) there is an effect of variations in the mass of the onion peel adsorbent on the physical properties of used cooking oil; (2) there is an effect of mass variation of onion peel adsorbent on the physical properties of used cooking oil; and (3) physicochemical properties of used cooking oil purified according to SNI 3741:2013. The research method uses an experimental research type with a quantitative approach. The study design used a completely randomized design (CRD). The data analysis technique used One Way ANOVA. The test parameters include odor test, color test, acid number test and peroxide number test. The adsorption temperature was constant at 70°C for 30 minutes, the mass variations of the onion peel adsorbent were 0 g (without onion skin), 5 g, 10 g, 15 g, and 20 g in 100 ml of used cooking oil. The results of the study of physical properties (smell and color), variations of 5 gr, 10 gr 15 gr and 20 gr produced "normal" odors, while variations of 10 gr, 15 gr and 20 gr color produced "normal". Furthermore, the chemical properties showed a decrease in the acid number after the purification process, the largest variation in the decrease in the acid number was in the 20 gr treatment as much as 74.56%, the largest decrease in the peroxide value in the 20 gr treatment as much as 90.63%.

Keywords: Physicochemical properties; Used Cooking Oil; Onion Skin *(Allium Cepa L.)*.

Citation: Rahmayanti, B.F., Citriadin, Y., Sulistiyana, S., Kamari, A., & Al-Mokaram, A. (2021). Physicochemical Properties Of Used Cooking Oil Purified Using Shallot (Allium Cepa L.) Pell Adsorbent. *Journal of Science and Science Education*, *2*(2), 84–90. https://doi.org/10.29303/jossed.v2i2.920

Introduction

The use of cooking oil many times is one of the habits of the people. This habit cannot be eliminated because cooking oil is a basic need. Repeated use of more than 3 times of frying causes a decrease in the quality of the oil which is characterized by a dark color change, unpleasant aroma, acid number and high peroxide value (Ihwan et al., 2019), this indicates that the oil has been damaged and is not good for use in consumption. The term used cooking oil explains the damage to cooking oil, used cooking oil is not good for consumption because it contains harmful cancer-causing ingredients such as free radicals (Haili, 2019).

The main damage to the oil is caused by the process of hydrolysis, oxidation and polymerization. Oxidation and polymerization processes can damage some vitamins and essential fatty acids in oil (Ihwan et al., 2019). Hydrolysis of oil can increase the acid number due to the reaction of water with fat so that it breaks down triglycerides into free fatty acids and glycerol which results in damage to the original color of

Email: Bqsrihandayani23@gmail.com (*Corresponding Author)

the oil. Hydrolysis of oil will be faster with acids, bases and enzymes (Kusumawardhani, 2016). Damage due to the oxidation process produces rancidity due to the reaction of air with oil, this reaction causes the breakdown of fatty acids into aldehydes and ketones.

Used cooking oil is a hazardous liquid waste that undergoes destruction which causes an increase in LDL (Low Density Lipoprotein) levels in the blood causing coronary heart disease, cancer, and hypertension. Another impact of the disposal of used cooking oil waste on the environment causes the soil to become arid and plant growth becomes difficult (Megiyo et al., 2017). Therefore, it is necessary to purify used cooking oil to reduce oil damage through the adsorption process using antioxidants.

Adsorption is a method that uses an absorption process on its surface (Barau et al., 2015). Adsorption is a condition in which a substance or particle can be adsorbed on the surface of the adsorbent. During the adsorption process, the adsorbent binds to ions and other molecular atoms (Evika, 2011). The adsorption process is strongly influenced by the size of the adsorbate molecule, the surface area of the adsorbent, pH, temperature, adsorbate concentration and contact or stirring time (Alamsyah et al., 2017).

Regeneration of used cooking oil using adsorbent aims to reduce the acid number and peroxide number. Purification methods using adsorbents have been widely used such as garlic (Mardiyah, 2018), shallots (Novitriani, 2015) and activated charcoal (Evika, 2011). One of the adsorbents used is onion peel adsorbent because it is a natural adsorbent that contains antioxidants whose effects are not harmful to health and can prevent the formation of free radicals.

Shallot skin contains flavonoid antioxidants, alkaloids, tannins, saponins and terpenoids which have antioxidant and antimicrobial properties. Its antioxidant and antimicrobial content can reduce rancid odors due to oil oxidation reactions and can kill bacteria, microorganisms that can damage food ingredients (Octaviani et al., 2019).

The purpose of this study was to determine the effect of mass variation of the onion peel adsorbent on the physicochemical properties of purified used cooking oil. It is hoped that this research can provide knowledge about the purification of used cooking oil using red onion peel antioxidants to reduce physical and chemical damage to the oil.

Method

Tools and Materials

The tools used are a calibrated analytical balance with an accuracy of at least 0.1 mg, burette, stative and clamps, erlenmeyer, measuring flask, watch glass, hotplate, 1 ml volume pipette, 100 mesh sieve, magnetic stirrer, stirring rod, stopwatch, beaker , measuring cup, pipette filler or rubber bulb, blender, mortar, filter paper.

The ingredients in this study used used cooking oil, onion skin (allium cepa L.), NaOH, 96% ethanol, chloroform, glacial acetic acid, potassium iodide (KI), sodium thiosulfate, phenophthalein indicator, starch indicator.

Work Procedures

1. Preparation of Used Cooking Oil: Filtered impurities in used cooking oil, allowed to stand for 1 day to precipitate the remaining impurities, then filtered used cooking oil again and analyzed for odor, color, acid number and peroxide value.
2. Preparation of Shallot Skin: Prepare the onion skin, dry by aerating, blend and sieve using a 100 mesh sieve.
3. Adsorption Process: Take 100 ml of filtered oil, add the onion peel adsorbent with variations of 0 g (without onion skin), 5 g, 10 g, 15 g and 20 g and heated at a temperature of 70°C. Stirred for 30 minutes, filtered and analyzed for odor, color, acid number and peroxide value.

Odor Test Parameters (SNI 3741:2013)

Samples of used cooking oil that have been purified are smelt to determine the odor produced. Prepare new cooking oil as a control, then compare the smell. A normal smell is characterized by the characteristic odor of cooking oil, if the smell is different then the oil is not normal (BSNI, 2013).

Color Test Parameters (SNI 3741:2013)

The used cooking oil samples after purification were analyzed for color, as a comparison, new cooking oil was prepared. If the color produced is yellow to pale yellow then the color is normal, but if the color is different then the color of the oil is not normal (BSNI, 2013).

Acid Number Test Parameters (SNI 3741:2013)

Samples of used cooking oil were taken as much as 10 grams and put into a 250 ml Erlenmeyer. Then added 50 ml of warm ethanol and 5 drops of phenophthalein indicator. Titrate using 0.1 N NaOH base until a pink color is formed which marks the end of the titration. The pink color lasts only for 30 seconds (BSNI, 2013).

$$\text{Acid Number } \left(mg\,\frac{NaOH}{gr}\right) = \frac{40 \times V \times N}{W} \quad \text{..................(1)}$$

Description :
V: Volume of NaOH used (ml)

N: Normality of NaOH solution, expressed in (N).
W: Tested sample weight (gr)

Peroxide Number Test Parameters (SNI 3741:2013)

Samples of used cooking oil were weighed as much as 5 grams and put in a 250 ml erlenmeyer. Then, 15 ml of glacial acetic acid: chloroform was added in a ratio of 3:2 (v/v), and the Erlenmeyer was shaken and closed until homogeneous. After being homogeneous, 2 ml of KI solution was added and shaken for 1 minute. then add 15 ml of distilled water and immediately close the Erlenmeyer while shaking, then add 0.5 ml of starch indicator and a blue color is formed. Then titrate with 0.1 N sodium thiosulfate solution until the blue color disappears (shake vigorously during titration to remove all iodine from the solvent). The blank was determined as a comparison solution (BSNI, 2013).

$$\text{Peroxide Number}\left(mek\,\frac{O_2}{kg}\right) = \frac{1000 \times N \times (Vo - V1)}{W} \ldots\ldots(2)$$

Description :
N : Normality sodium thiosulfate 0.1 N
Vo : Volume of 0.1 N sodium thiosulfate solution used for titration (ml)
V_1 : Volume of 0.1 N sodium thiosulfate solution used for blank titration (ml)
W : Sample weight (g)

Result and Discussion

Onion Skin

Shallot skin used as an adsorbent is onion skin that has gone through a drying process with air. Drying using air is better for secondary metabolites in onion skin, because most plants have different secondary metabolites. Shallot skin has secondary metabolites in the form of flavonoids which do not disappear when dried in the air. Onion skin in dry conditions has higher antioxidant and antibacterial properties. During the drying process the moisture content evaporates into the air, so it becomes dry and loses water.

Research on the purification of used cooking oil has been carried out with various adsorbents to determine the success rate of purification. There was a decrease in the number of peroxides in each treatment using garlic adsorbent. The more antioxidants in garlic, the greater the decrease in peroxide value (Mardiyah, 2018). Using onion adsorbents to inhibit the formation of peroxides and iodine in bulk oil after frying, the results are the peroxide value and iodine value according to SNI requirements (Korry and Nurjanah, 2015). The use of shallots and garlic as adsorbents has the disadvantage of being quite expensive.

One alternative that can be used to reduce costs is to use onion peel as an adsorbent, because the onion skin is easy to find, besides that the onion skin has a higher antioxidant content than the tuber. Using onion peel and bagasse as adsorbents in improving odor, color, acid number and peroxide value (Haili, 2019). The results of the study showed that the highest acid number decreased in the 0:10 treatment of onion skin and was in accordance with the requirements of SNI 3741:2013 regarding the use of cooking oil, the highest peroxide value decreased in the variation (10:0) of onion skin: bagasse and has complied with the requirements of SNI 3741:2013.

Figure 1. Red Onion Skin Powder

Onion skin dried using air in a blender until smooth, the goal is to blend it to form small powders. Small powders have more absorption or active sites as absorbents. After blending filtered or sieved with a 100 mesh sieve. The 100 mesh sieve has very small sieve particles, so the powder obtained is very small. However, the smaller the particle size of the powder, the better the absorption process against impurities.

Quality Used Cooking Oil Refining

1. Odor Test Result Parameter

The smell or aroma of the oil is one of the physical damage caused by the oil oxidation process. Based on table 1, it can be seen how the effect of adding the onion peel adsorbent to the odor generated. Each treatment after being compared with new oil, without treatment with onion skin the smell was not normal, but in the 5 gr, 10 gr, 15 gr and 20 gr treatments the odor produced was normal.

Table 1. The Results Of The Used Cooking Oil Odor Test Before And After Purification

No	Treatment Onion skin (gr)	Odor test Before purification	After purification
1	0 (control)	Abnormal	Abnormal
2	5	Abnormal	Normal
3	10	Abnormal	Normal
4	15	Abnormal	Normal
5	20	Abnormal	Normal

The rancid smell of used cooking oil is caused by the side reaction of oil oxidation with air in the form of aldehydes and ketones that cause unpleasant odors. Antioxidants in the skin of shallots such as flavonoids, alkaloids, tannins, saponins, and terpenoids. The rancid odor of used cooking oil is caused by side reactions of oxidation. oil with air in the form of aldehydes and ketones that cause unpleasant odors. The antioxidant content in onion skin can improve the rancid smell of used cooking oil. The -OH group on the onion peel adsorbent functions to bind free radicals that cause rancid odor (Haili, 2019) with (At): onion skin (Kbm) without treatment the smell of used cooking oil is not normal, 0:10 the smell is normal, 2.5:7.5 , 5:5 produces an abnormal odor, 7.5:2.5 and 10:0 produces a normal odor.

Comparison of the results of Haili's (2019) research with the researchers both improved the smell of used cooking oil, the difference was that previous researchers used sugarcane bagasse and onion peel adsorbents, while the researchers only used onion peels. In addition, the difference is in the variation of the adsorbent used, in previous studies the smell was normal at variations 0:10, 7.5:2.5 and 10:0 (bagasse: onion peel), while variations 2.5:7.5 and 5:5 were not normal, researchers used variations of 5 gr, 10 gr, 15 gr and 20 gr with normal odor results.

2. Color Test Result Parameter

The color of the oil can be used as a test to determine the damage to cooking oil. Based on table 2, it can be seen the effect of new cooking oil on the addition of onion peel adsorbent on the color of used cooking oil. Fresh cooking oil was prepared for comparison, without the addition of onion peel adsorbent, the color of the used cooking oil was brownish and abnormal. In the treatment of 5 g of onion skin the color after purification was not normal, while in the treatment of 10 g, 15 g and 20 g the color of the oil was normal after purification. The more adsorbent, the better and clearer the color of the oil.

Table 2. Color Test Results Of Used Cooking Oil Before And After Purification

No	Treatment Onion skin (gr)	Color test Before purification	After purification
1	0 (control)	Abnormal	Abnormal
2	5	Abnormal	Abnormal
3	10	Abnormal	Normal
4	15	Abnormal	Normal
5	20	Abnormal	Normal

The brown and cloudy color of used cooking oil is the result of the oxidation of unsaturated fats and the use of high temperatures. The unattractive color can reduce the quality of the oil, the brownish and cloudy color can be removed by the addition of an adsorbent. The content of flavonoids, alkaloids, saponins, tannins and terpenoids can bind dyes from the oxidation of oil. The color particles are absorbed at the active site of the adsorbent so that the color of the oil is clear again (Kusumawardhani, 2016).

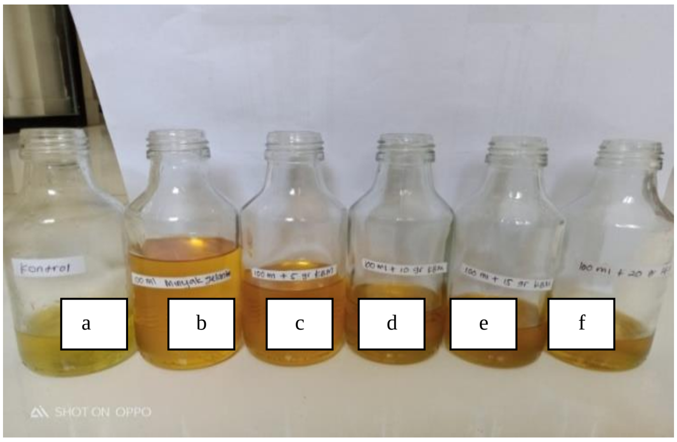

Figure 2. (a) control; (b) used oil; (c) 5 gr onion skin; (d) 10 gr onion skin; (e) 15 gr onion skin; (f) 20 gr onion skin. Color Of Used Cooking Oil After Purification

Utilizing onion skin and bagasse, treatment of bagasse (At): onion skin (Kbm) without color treatment of used cooking oil was not normal, 0:10, 2.5:7.5, 5:5, 7.5:2.5 and 10:0 resulted normal color (Haili, 2019).

Comparison of the results of Haili's (2019) research with researchers both improving the color of used cooking oil, the difference lies in the adsorbent used and the variation of the adsorbent, previous researchers used bagasse: onion peel with variations 0:10, 2.5:7.5, 5:5, and 7.5:2.5 produces a normal color while 10:0 is not normal, while the researchers used onion skin with variations of 5 grams of abnormal color, 10 grams, 15 grams and 20 grams of normal colors.

3. Acid Number Result Parameter

The acid number indicates the number of milligrams of NaOH required to neutralize free fatty acids in 1 g of oil. The results of the study of the acid number of used cooking oil showed a decrease after being adsorbed using onion skin, in (Figure 2) it was seen a decrease in the acid number of used cooking oil. Before purification, the acid number of the oil was 1.808 mg NaOH/gr while the acid number after purification in the 5 gr, 10 gr, 15 gr and 20 gr treatments was 0.89, 0.56, 0.52, and 0.46 (mg NaOH/gr, respectively). The decrease in the acid number in each treatment was higher, the more the onion peel adsorbent, the lower the acid number in used cooking oil.

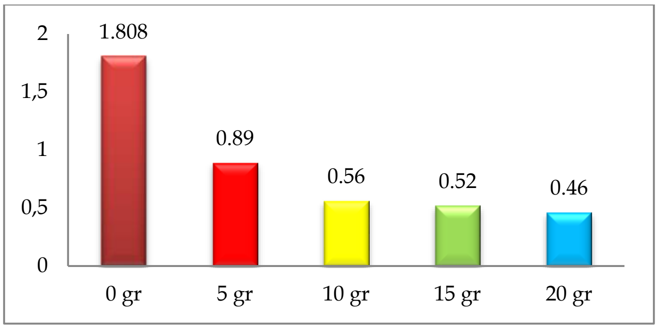

Figure 3. Average Number Of Used Cooking Acid After Purification Using Shallot Skin

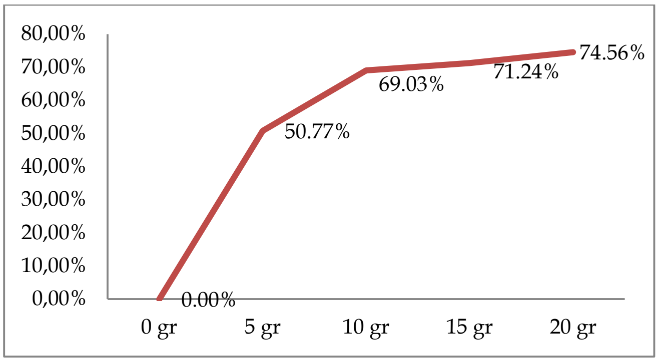

Figure 4. Reduction Percentage Of Used Cooking Oil Acid Number After Purification Using Red Onion Skin

Free fatty acids can be separated using NaOH or KOH bases, the base serves as a neutralizer to separate free fatty acids. Natural antioxidants in the skin of shallots contain –OH groups which can react with the –COOH groups in the oil so that hydrolysis of the oil can be minimized as seen from the reduced levels of free fatty acids in the oil (Suartini et al., 2018).

Based on the results of analysis of variance, the value of F_{count} is greater than F_{table} for the acid number test of used cooking oil after purification using onion peel adsorbent. At a significant level of 5%, it shows that there is a significant difference in each treatment. Based on this, there is a significant effect on each mass variation of the onion peel adsorbent, and it has met the requirements for the use of cooking oil permitted by SNI 3741:2013. Because there is a real effect, then the BNT test is continued. In (Table 1) the results of the BNT test for each red onion skin treatment gave a different notation, except for the 10 g and 15 g treatments which showed the same notation, meaning that they were not significantly different.

Table 3. LSD Test Results Against Acid Number Used Cooking Oil

No	Treatment	Average	Notation
1	0 gr	1.808	d
2	5 gr	0.89	c
3	10 gr	0.56	b
4	15 gr	0.52	b
5	20 gr	0.46	a

Previous research used activated charcoal as an adsorbent of coconut husk and onion extract for purification of used cooking oil. The results of his research showed that the best acid number reduction conditions at a temperature of 60°C were 88.07% with an acid number of 0.2900 mg NaOH/gr. Previous research by Haili (2019) used onion peel and bagasse as an adsorbent to purify used cooking oil. The results showed that the best decrease in acid number was in the variation of 7.5:2.5 (bagasse: onion skin) which was 0.4930 mg NaOH/gr.

Comparison of previous studies with researchers both can reduce the acid number of used cooking oil, the results of this study are the largest decrease in the acid number of used cooking oil in the treatment of 20 grams of onion skin, which is 0.46 mg NaOH/gr or 74.56%. While Haili (2019) using activated charcoal as adsorbents of coconut husk and onion extract gave a greater decrease in acid number because temperature affects the adsorption process.

4. Peroxide Number Result Parameter

The peroxide number indicates the number of milliequivalents of peroxide in 100 g of oil or 1 kg of oil. The peroxide number indicates the extent of damage to the oil. The results of the study in (Figure 4) show a decrease in the number of peroxides in used cooking oil after adsorption using onion peel. Before purification, the peroxide value of used cooking oil is 12.8 mek O_2/100 gr. After purification using onion peel adsorbent, the peroxide value decreased, in the treatment of 5 g, 10 g, 15 g, and 20 g, respectively, by 8.8, 5.6, 3.2 and 1.2 (mek O_2/100 gr). The more adsorbent of the onion skin, the higher the decrease in the peroxide value of used cooking oil.

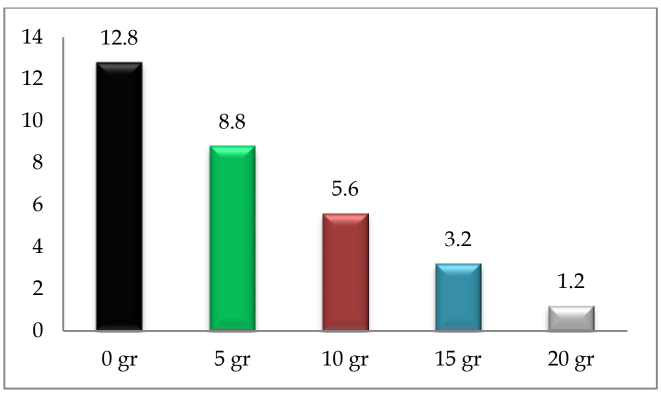

Figure 5. Average Peroxide Number Of Used Cooking Oil After Purification Using Red Onion Skin Adsorbent

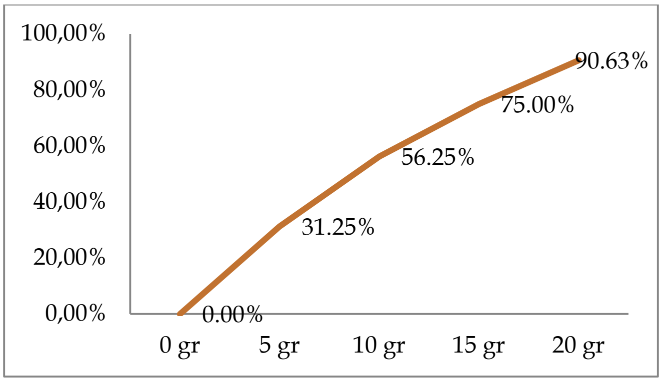

Figure 6. Percentage Reduction In Peroxide Number Of Used Cooking Oil After Purification Using Red Onion Skin Adsorbent

Determination of peroxide number can be done by titration using sodium thiosulfate. The addition of KI as a reducing agent which functions to reduce hydroperoxides by releasing iodine, the released iodine is absorbed by the starch indicator to produce a blue iodine complex. The blue color can be removed by titrating again with sodium thiosulfate until all the iodine is released and the end point of the titration is reached (Barau et al., 2015).

A high peroxide value indicates the extent of damage to the oil. Oxidation reactions in oil are formed due to the contact between oil and oxygen. The reaction produces peroxides and hydroperoxides, aldehydes, ketones and short chain fatty acids.

Antioxidants in the skin of the onion can reduce the level of peroxide in used cooking oil. Antioxidant compounds have –OH groups and double bonds that are able to bind free radicals, these reactions produce new free radicals that are less reactive (Parwata, 2016).

Based on the results of the analysis of variance data, the Fcount value is greater than Ftable with a significant level of 5%, so that according to the test decision there is a significant difference in each treatment. This means that there is an effect of variations in the mass of the onion peel adsorbent on the peroxide value of used cooking oil and it meets the requirements of SNI 3741:2013. Because there is a significant difference, continue with the BNT test. In (Table 2) the results of the BNT test for each red onion skin treatment give different notations, meaning that it is significantly different in each treatment.

Table 4. LSD Test Results Against Peroxide Number Of Used Cooking Oil

No	Treatment	Average	Notation
1	0 gr	12.8	e
2	5 gr	8.8	d
3	10 gr	5.6	c
4	15 gr	3.2	b
5	20 gr	1.2	a

The results of research by Novitriani (2015) using red onion as an inhibitor of peroxide formation, the result is that before the bulk oil is fried the peroxide value is 0.3838 meq/kg, after frying with adsorbent it becomes 1.5348 meq/kg and frying without adsorbent as much as 8.3463 meq/kg. Previous research by Haili used onion peel and bagasse as an adsorbent to purify used cooking oil. The results showed that the highest peroxide value was treated with bagasse (At): onion skin (Kbm) 0:10 the result was 0 mek O_2/gr, at a temperature of 70°C and adsorption for 30 minutes.

Comparison of previous studies with researchers both can reduce the peroxide number in used cooking oil, the results of this study the largest decrease in the peroxide value of used cooking oil in the treatment of 20 g of onion skin, namely 1.2 mek O_2/gr or 90.63%. The results showed that the mass variation of the onion peel adsorbent determines the amount of reduction in the peroxide value of used cooking oil.

Conclusion

The results of the research: (1) There is an effect of variations in the mass of the onion peel adsorbent which has a significant effect on the physical properties of used cooking oil, namely odor and color; (2) The mass variation of the onion peel adsorbent has a significant effect on the chemical properties of used cooking oil, namely acid number and peroxide number. The acid number according to SNI 3741:2013 at variations of 10 gr, 15 gr and 20 gr, while the peroxide value according to SNI 3741:2013 at variations of 5 gr, 10 gr, 15 gr and 20 gr; (3) Purification of used cooking oil using onion peel as an adsorbent improves the physicochemical properties of the oil. The results of the study on the variation of 10 g, 15 g and 20 g are feasible and meet the requirements of SNI 3741:2013, allowing consumption of cooking oil.

Acknowledgements

On this occasion the author would like to thank the Tadris Chemistry Laboratory, Mataram State Islamic University which has funded this research with the title "Physicochemical Properties of Used Cooking Oil Purified Using Shallot *(Allium Cepa L.)* Peel Adsorbent".

References

Alamsyah, M., Kalla, R., & La Ifa, L. I. (2017). Pemurnian Minyak Jelantah Dengan Proses Adsorbsi. *Journal Of Chemical Process Engineering*, 2(2), 22. https://doi.org/10.33536/jcpe.v2i2.162.

Barau, F., Nuryanti, S., & Pursitasari, I. D. (2015). Buah Mengkudu (Morinda Citrifolia L.) sebagai Pengadsorbi Minyak Jelantah. *Jurnal Akademika Kimia*, *4*(1), 8–16.

Evika. (2011). *Use of Coconut Shell Activated Charcoal Adsorbent in Purification of Used Cooking Oil*. Thesis, FTK Sultan Syarif Kasim State Islamic University, Riau, Pekanbaru.

Haili, H.M. (2019). *Utilization of Waste Shallot Skin (Allium Cepa L.) and Sugarcane Bagasse as Adsorbents in Purification of Used Cooking Oil.* Thesis, FTK UIN Mataram, Mataram.

Ihwan, I., Fadlia, F., & Anam, S. (2019). Quality of Used Cooking Oil With Snake Fruit (Salacca zalacca (Gaertn.) Voss) Seed Adsorbent Using Parameters of Peroxide Value and Free Fatty Acids. *Jurnal Farmasi Galenika (Galenika Journal of Pharmacy) (e-Journal)*, *5*(2), 124 - 131. https://doi.org/10.22487/j24428744.2019.v5.i2.10070.

Indonesian National Standards Agency (BSNI). (2013). *Cooking Oil SNI 3741:2013*. Jakarta: BSNI.

Kusumawardhani, D.A. (2016). *Utilization of Aking Rice Waste as an Adsorbent to Reduce Free Fatty Acid Levels in Used Cooking Oil*. Thesis. Faculty of Mathematics and Natural Sciences ITS, Surabaya

Mardiyah, S. (2018). Efek Anti Oksidan Bawang Putih terhadap Penurunan Bilangan Peroksida Minyak Jelantah. *The Journal of Muhammadiyah Medical Laboratory Technologist*, *1*(2), 98. https://doi.org/10.30651/jmlt.v1i2.1543.

Megiyo, M., Aldila, H., Afriani, F., Gus Mahardika, R., & Enggiwanto, S. (2017). Sintesis Karbon Aktif Tempurung Ketapang (Terminalia catappa) Sebagai Adsorben Minyak Jelantah. *Prosiding SNFA (Seminar Nasional Fisika Dan Aplikasinya)*, *2*, 137. https://doi.org/10.20961/prosidingsnfa.v2i0.16382

Novitriani, K. (2015). Penambahan Bawang Merah (Allium ascalonicum) Untuk Menghambat Laju Pembentukan Peroksida Dan Iodium Pada Minyak Curah. *Jurnal Kesehatan Bakti Tunas Husada: Jurnal Ilmu-Ilmu Keperawatan, Analis Kesehatan Dan Farmasi*, *13*(1). https://doi.org/10.36465/jkbth.v13i1.12

Octaviani, M., Fadhli, H., & Yuneistya, E. (2019). Uji Aktivitas Antimikroba Ekstrak Etanol dari Kulit Bawang Merah (Allium cepa L.) dengan Metode Difusi Cakram. *Pharmaceutical Sciences And Research*, *6*(1), 62–68.

Parwata, I.M.O.A. (2016). *Antioxidant Teaching Materials*, Bali: Udayana University.

Suartini, N., Jamaluddin, J., & Ihwan, I. (2018). Pemanfaatan Arang Aktif Kulit Buah Sukun (Artocarpus altilis (Parkinson) Fosberg) Sebagai Adsorben Dalam Perbaikan Mutu Minyak Jelantah. *Kovalen*, *4*(2), 152–165